



Beam Energy Scan on Hypertriton Production and Lifetime Measurement

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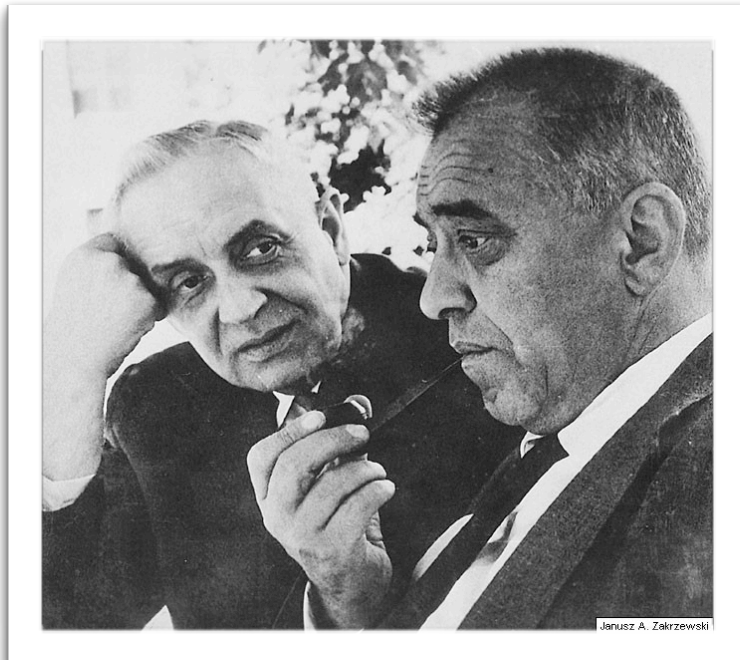
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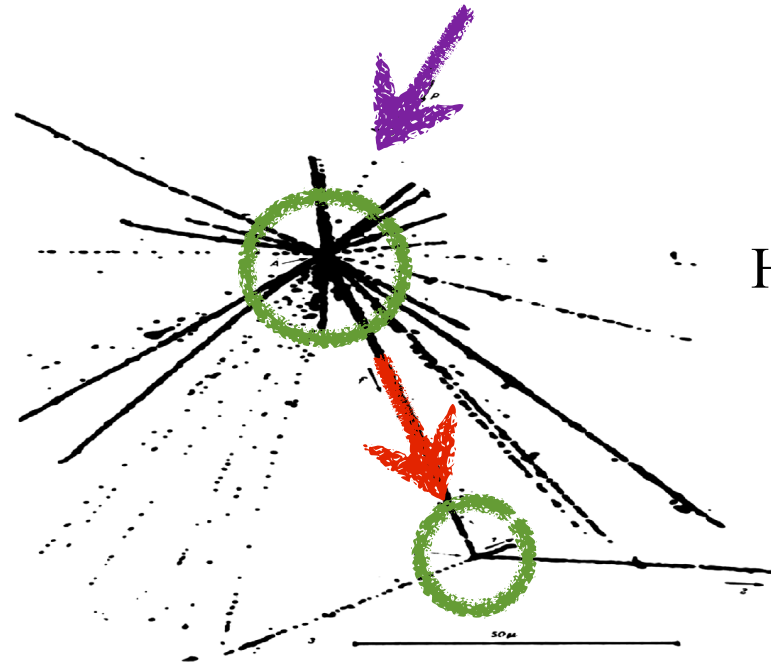
- ★ Introduction and Motivation
- ★ Analysis Details
- ★ ${}^3_{\Lambda}\text{H}$ Production at $\sqrt{s_{NN}} = 7.7, 11.5, 19.6, 27, 39, 200 \text{ GeV}$
- ★ BES-I Projection on Energy Dependence of Strangeness Population Factor
- ★ BES-I Projection on Hypertriton Lifetime
- ★ Conclusions and QM2012 Plan

Hypernucleus

Hypernucleus: Nucleus which contains at least one hyperon in addition to nucleons.



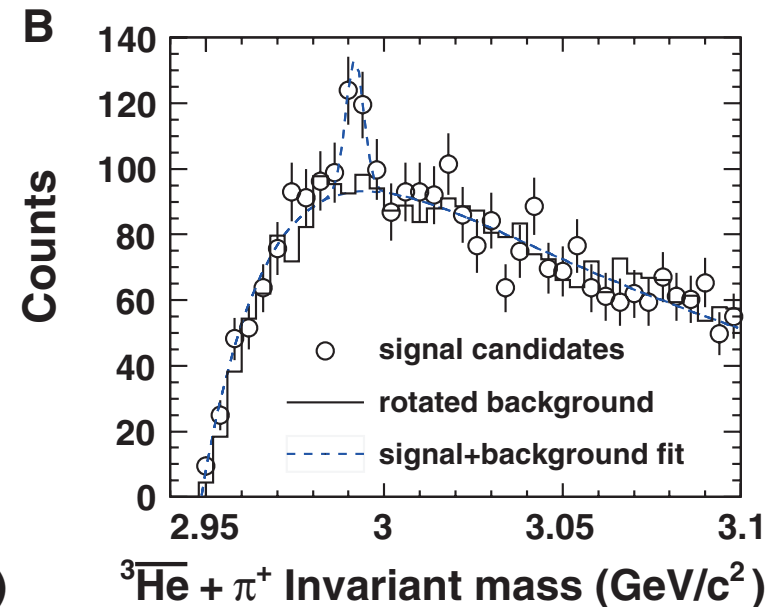
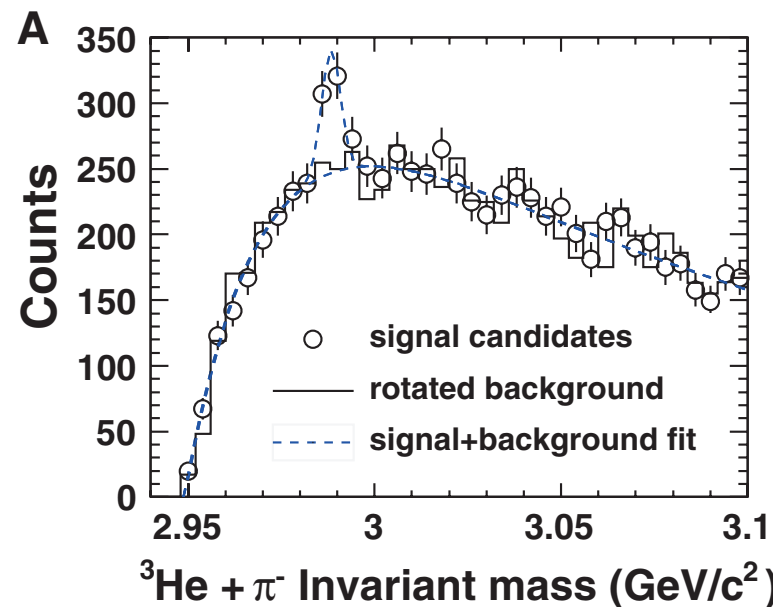
M. Danysz and J. Pniewski, Phil. Mag. 44 (1953) 348



Hyperon-Nucleon (Y-N) Interaction

Helps to understand strong interactions
Helps to study neutron stars

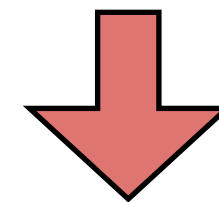
Binding energy and lifetime are sensitive to Y-N interactions



Hypernucleus of Lowest A

$^3_{\Lambda}\text{H}(\text{p}+\text{n}+\Lambda)$ (Hypertriton)

$^3_{\bar{\Lambda}}\bar{\text{H}}(\bar{\text{p}}+\bar{\text{n}}+\bar{\Lambda})$ (Antihypertriton)



Easiest to be produced in HIC

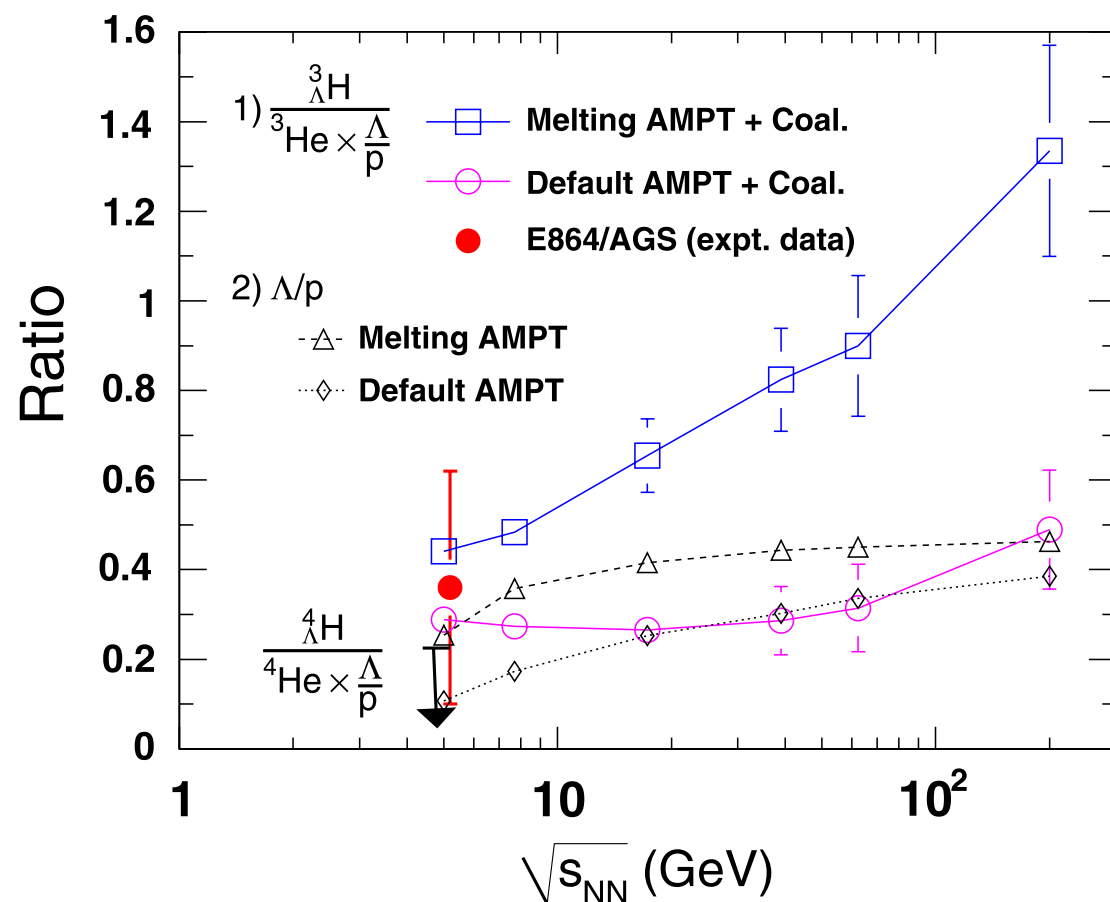
STAR Collaboration, SCIENCE 328, 58 (2010)

Hints on QCD Phase Transition

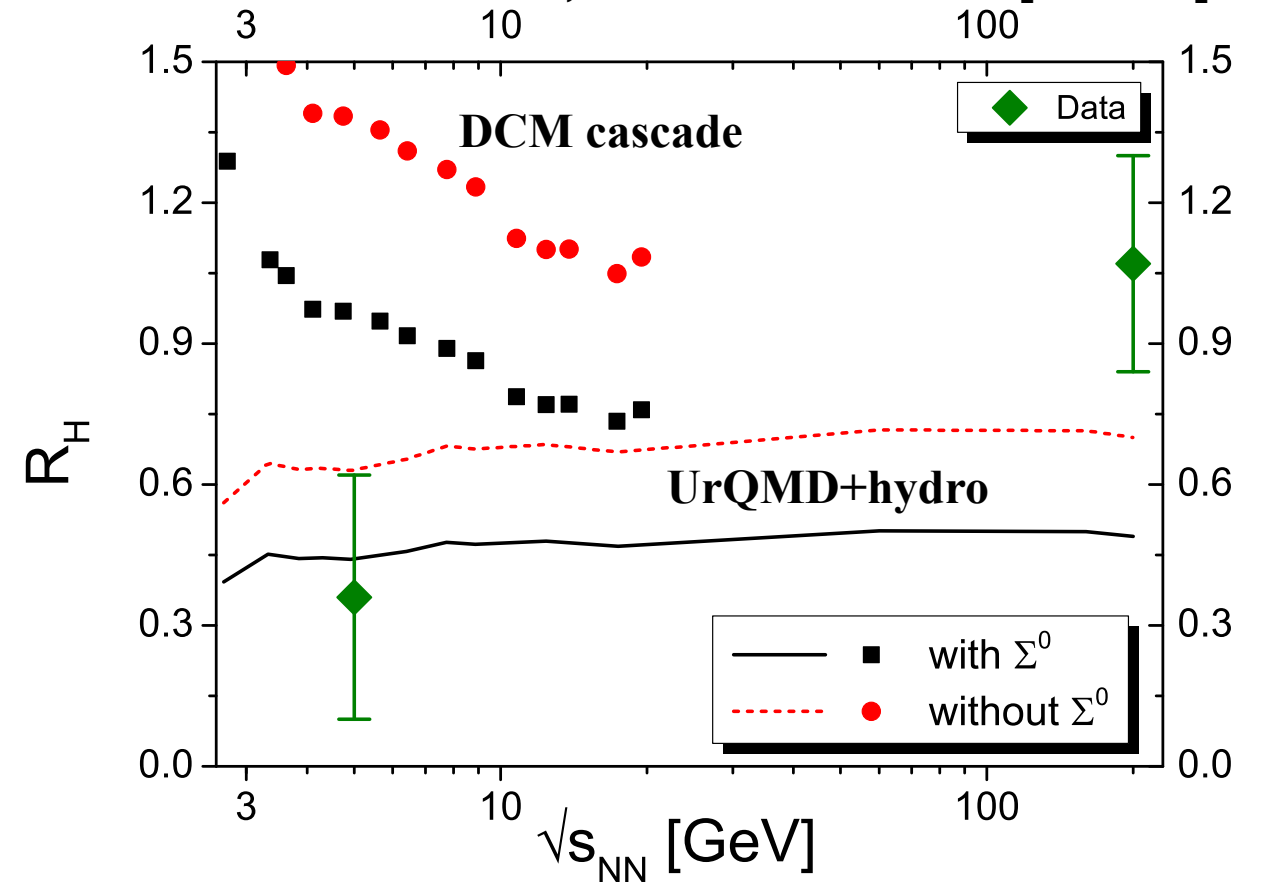
Strangeness Population Factor

$$S_3 = \frac{{}^3_{\Lambda}\text{H}}{{}^3\text{He} \times \Lambda/p}$$

S.Zhang et al., PLB 684 (2010) 224



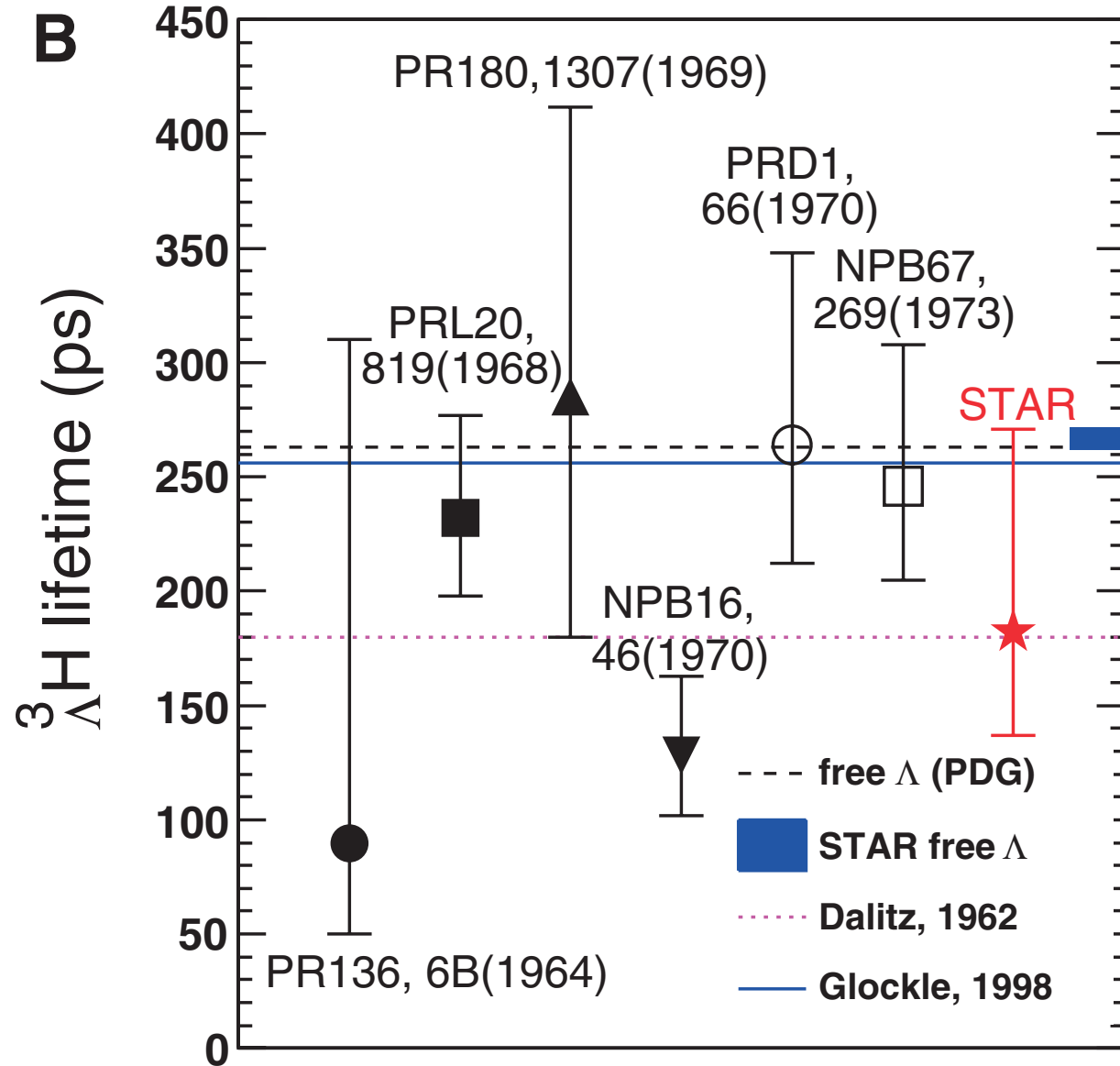
J. Steinheimer et al., arXiv:1203.2547v1 [nucl-th]



It is predicted that the beam energy dependence of S_3 would behave differently in pure hadron gas and QGP.

Previous Lifetime Measurement

STAR Collaboration, SCIENCE 328, 58 (2010)



STAR Latest Measurement

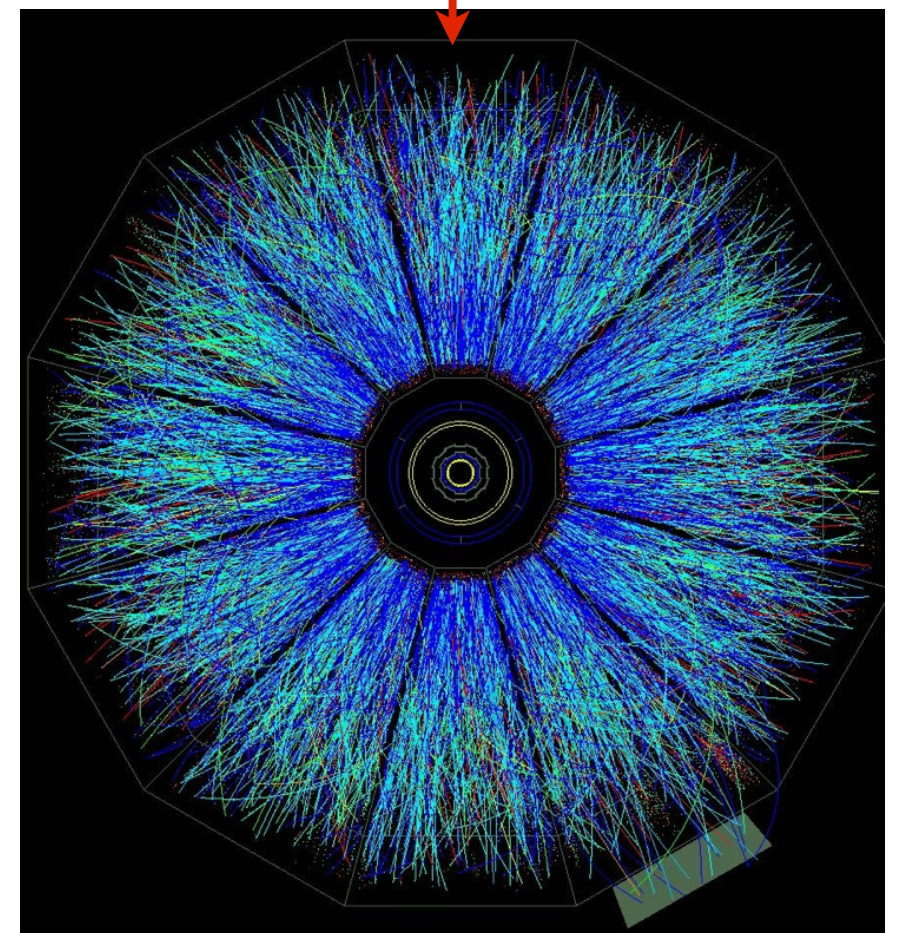
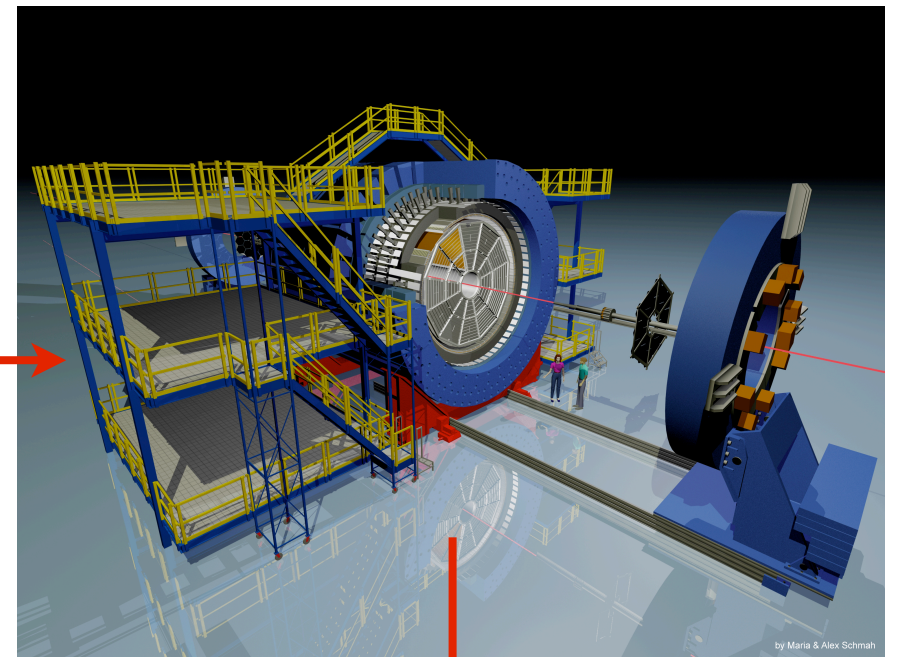
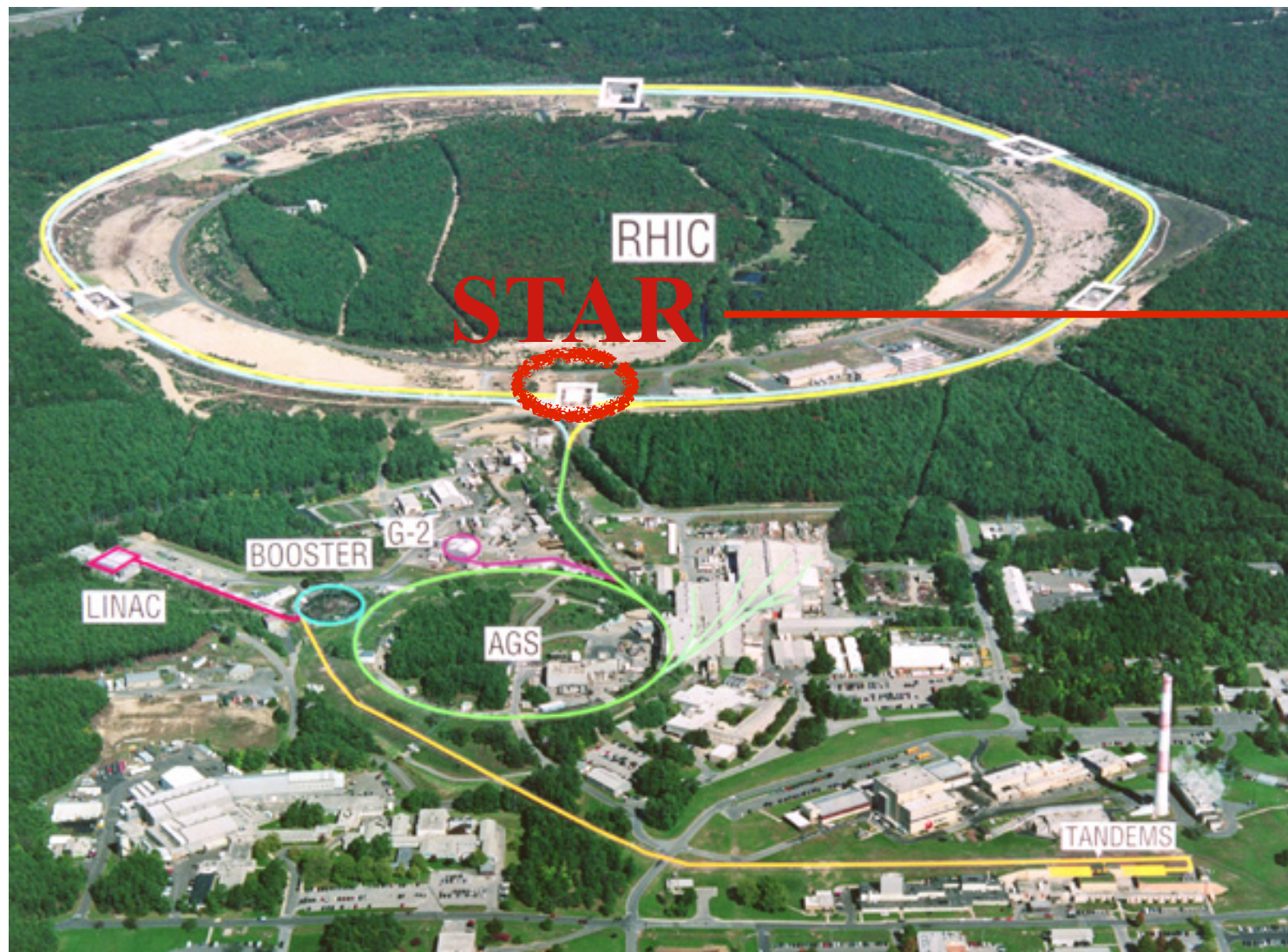
Run4 200GeV	minbias	22M
Run4 200GeV	central	23M
Run7 200GeV	minbias	68M

How much do we have now?

Run10 200GeV	minbias	~220M
Run10 200GeV	central	~180M
Run11 200GeV	minbias	~580M
Low Energies	minbias	~212M

It is promising to obtain an improved lifetime measurement result using present datasets.

Relativistic Heavy Ion Collider(RHIC)



The Relativistic Heavy Ion Collider is a heavy-ion collider and a spin-polarized proton collider.

Au+Au: Top 200GeV, BES I(from 7.7 to 39GeV)

p+p: Top 500GeV, 200GeV

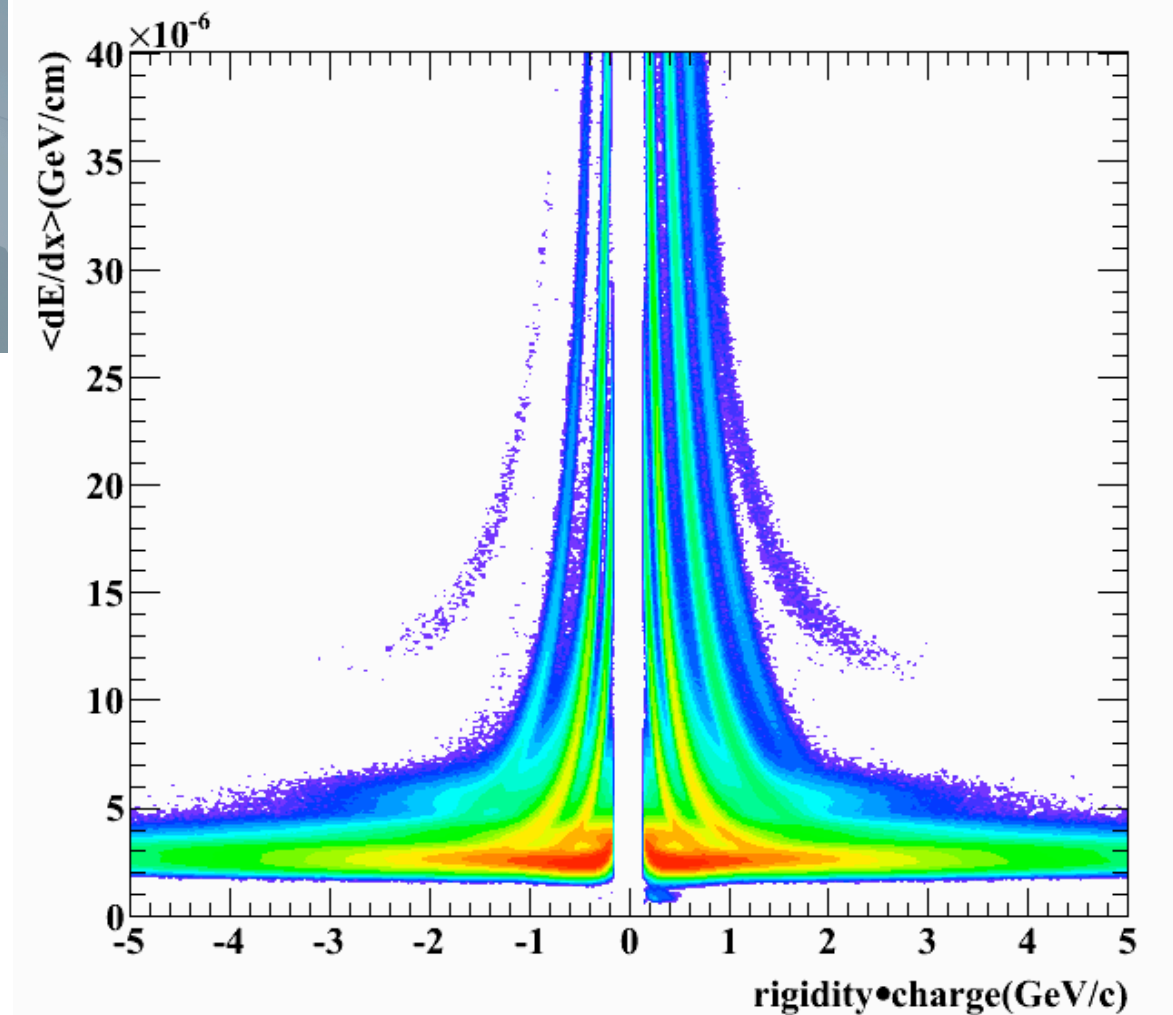
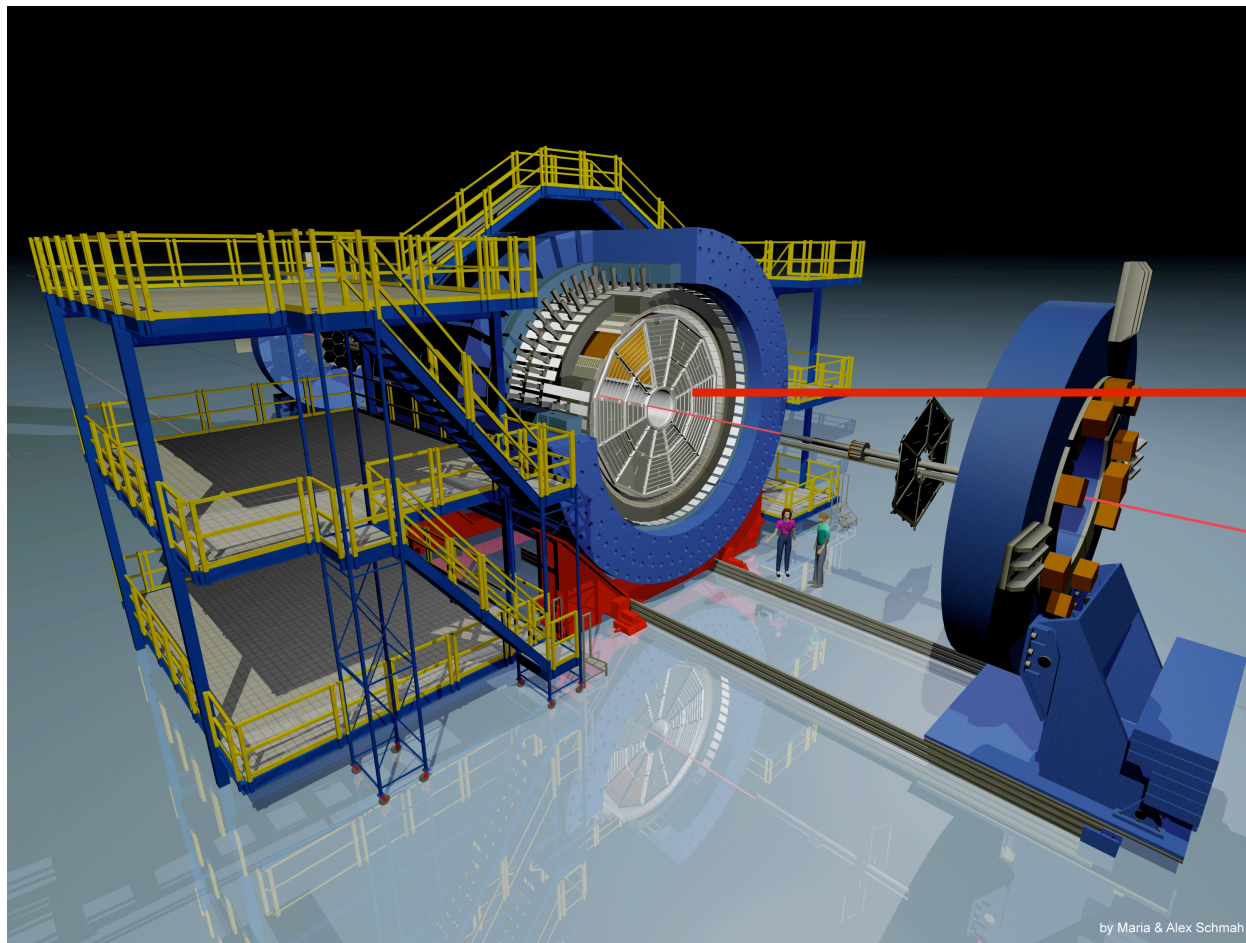
Particle Identification

Time Projection Chamber

$$(0 < \phi < 2\pi, |\eta| < 1)$$

Tracking – momentum

Ionization energy loss – dE/dx



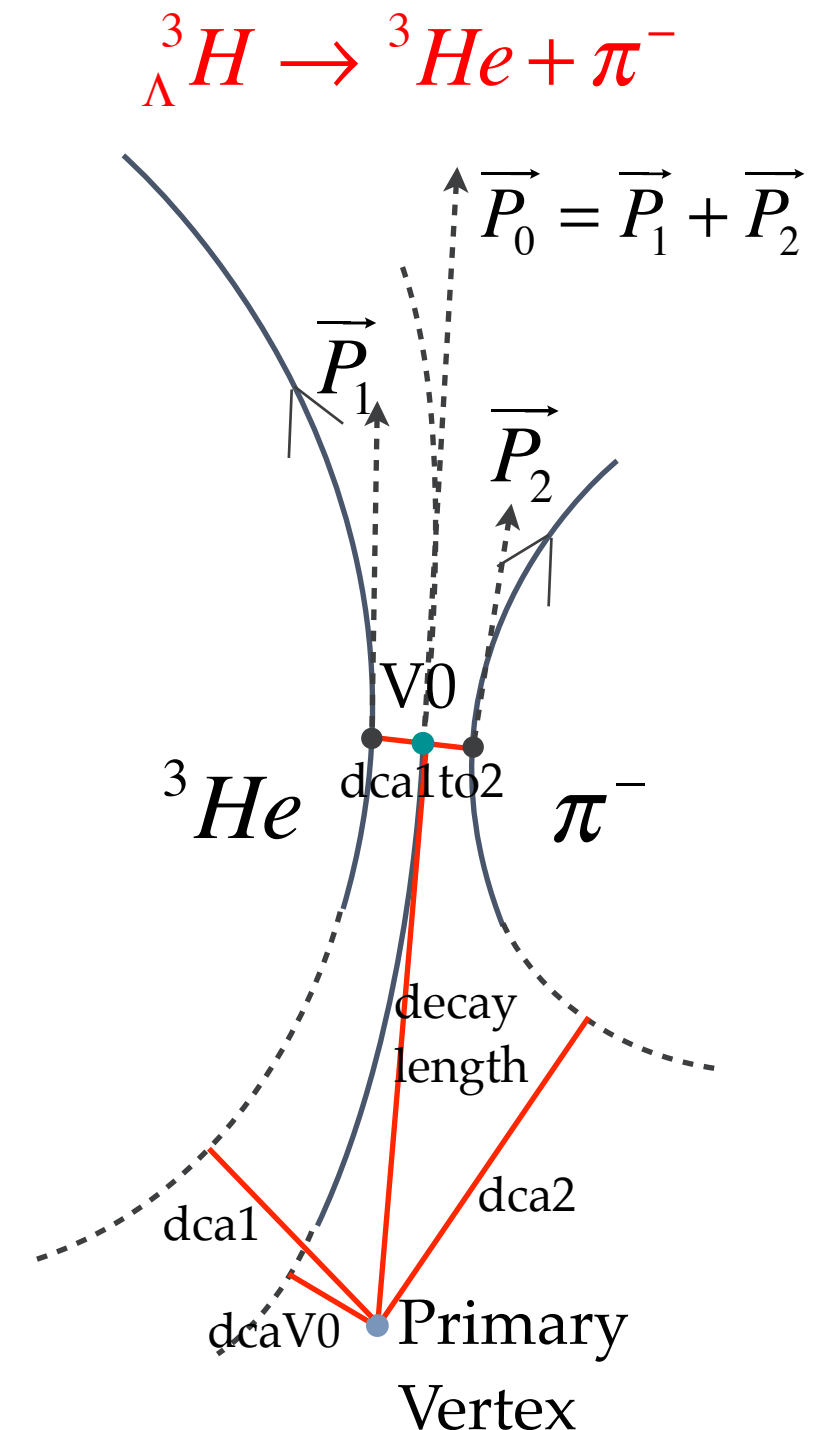
★ Datasets

Datasets Used		
Run10 7.7GeV	minbias	3.98M
Run10 11.5GeV	minbias	10.98M
Run11 19.6GeV	minbias	31.15M
Run11 27GeV	minbias	48.65M
Run10 39GeV	minbias	118.02M
Run10 200GeV	minbias	222.73M
Run10 200GeV	central	199.07M
Run7 200GeV	minbias	56.31M

★ Analysis Method: Secondary Vertex Finding Technique

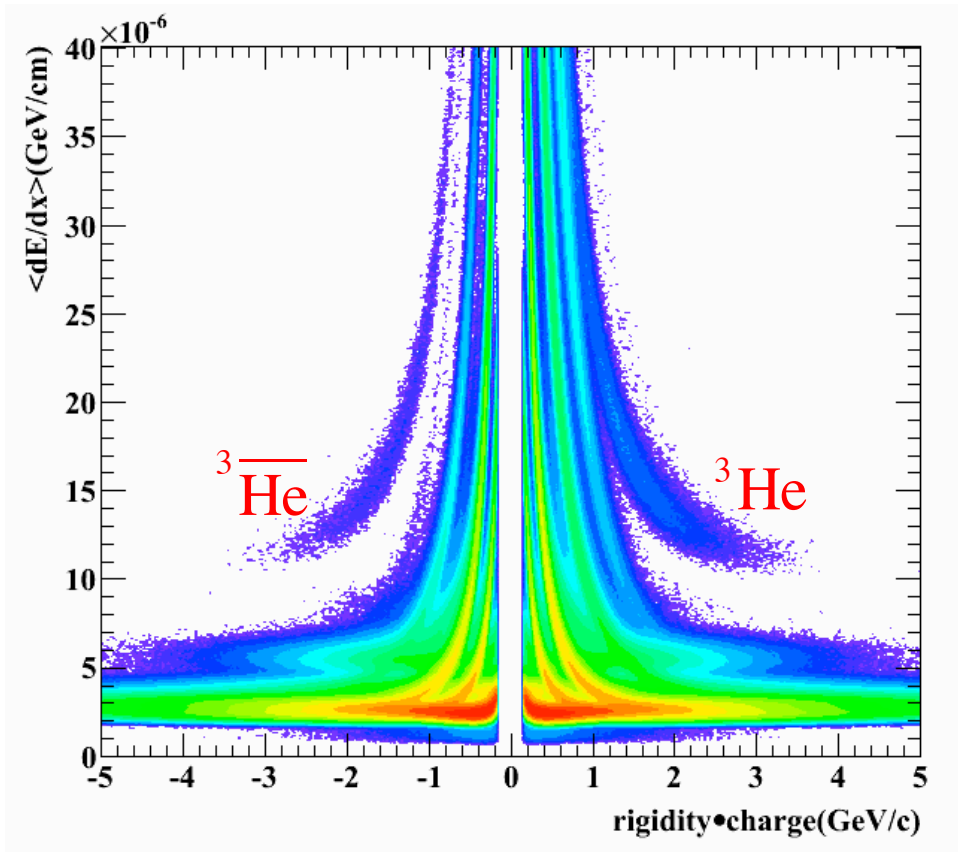
- ★ Find helium-3 and pion helices
- ★ Analyze each possible helium-3 and pion pair and give appropriate V0 cuts
- ★ Plot the invariant mass spectra

Secondary vertex finding technique

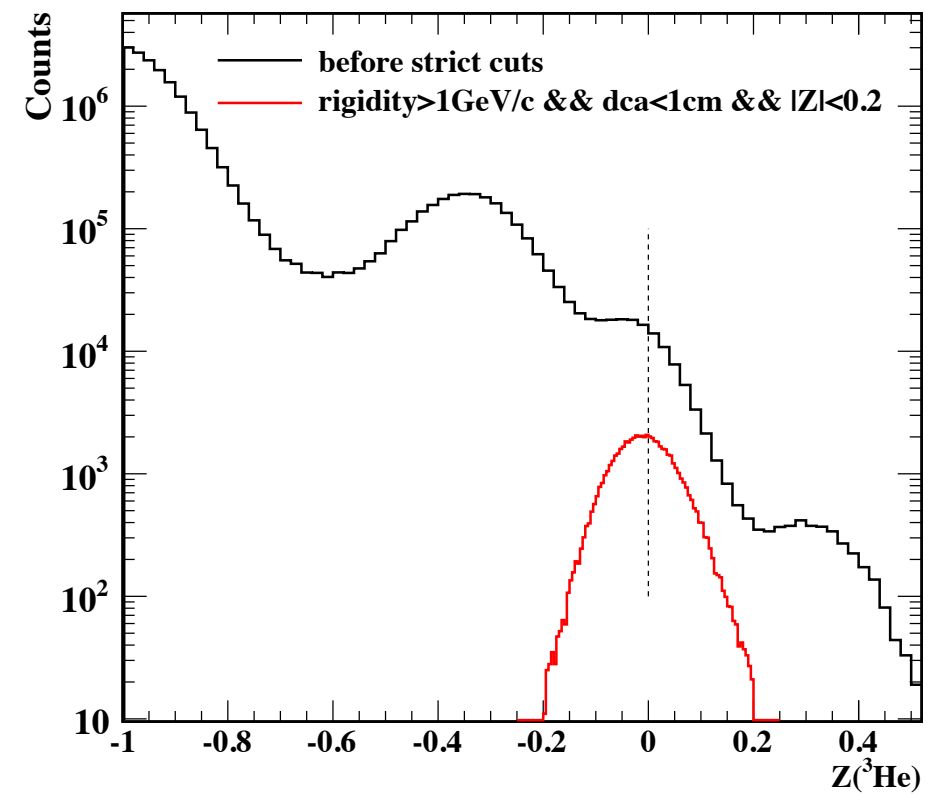


Daughter Identification

★ ${}^3\text{He}$



$$Z = \ln\left(\frac{dE/dx^{data}}{dE/dx^{Bichsel}}\right)$$

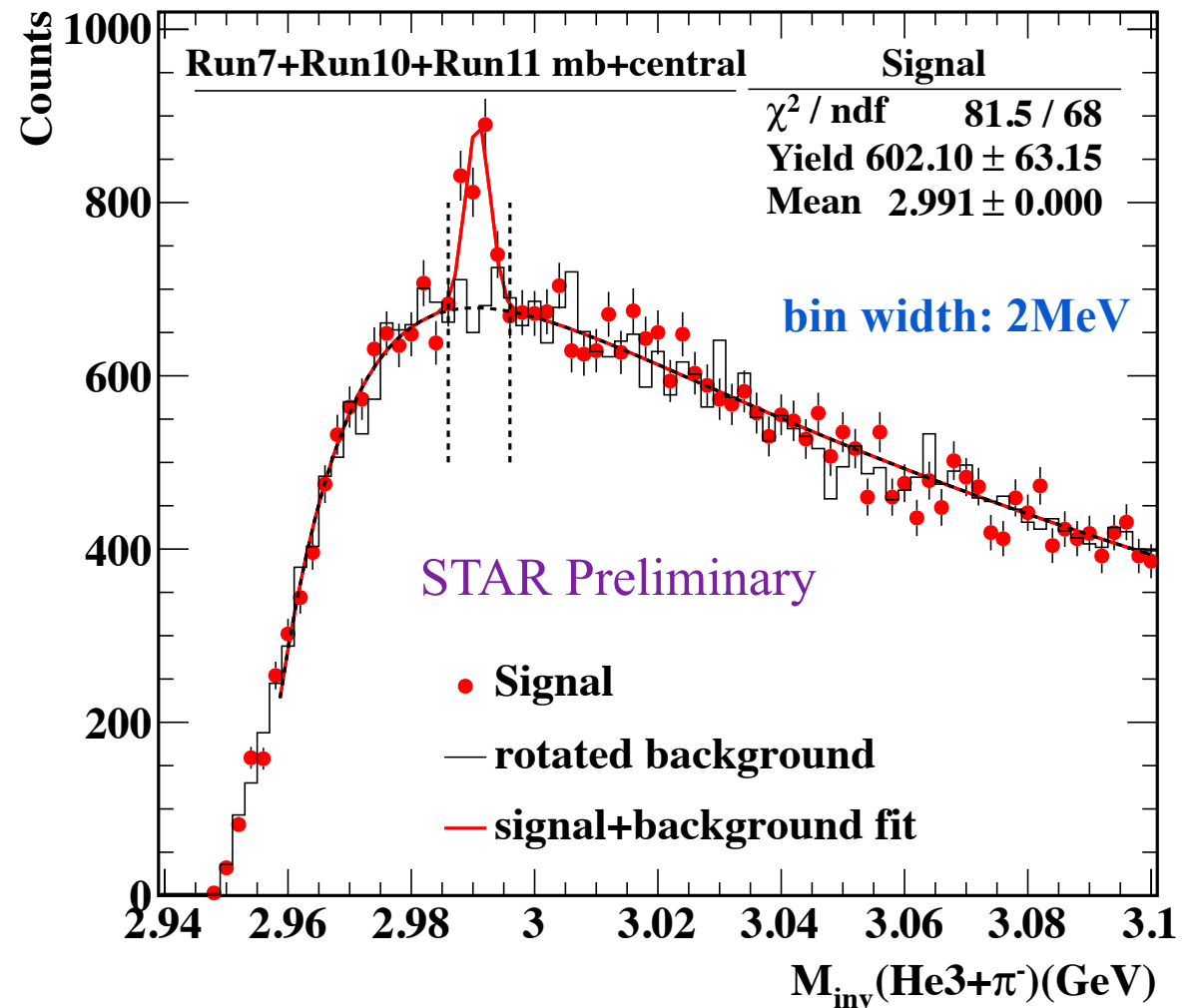
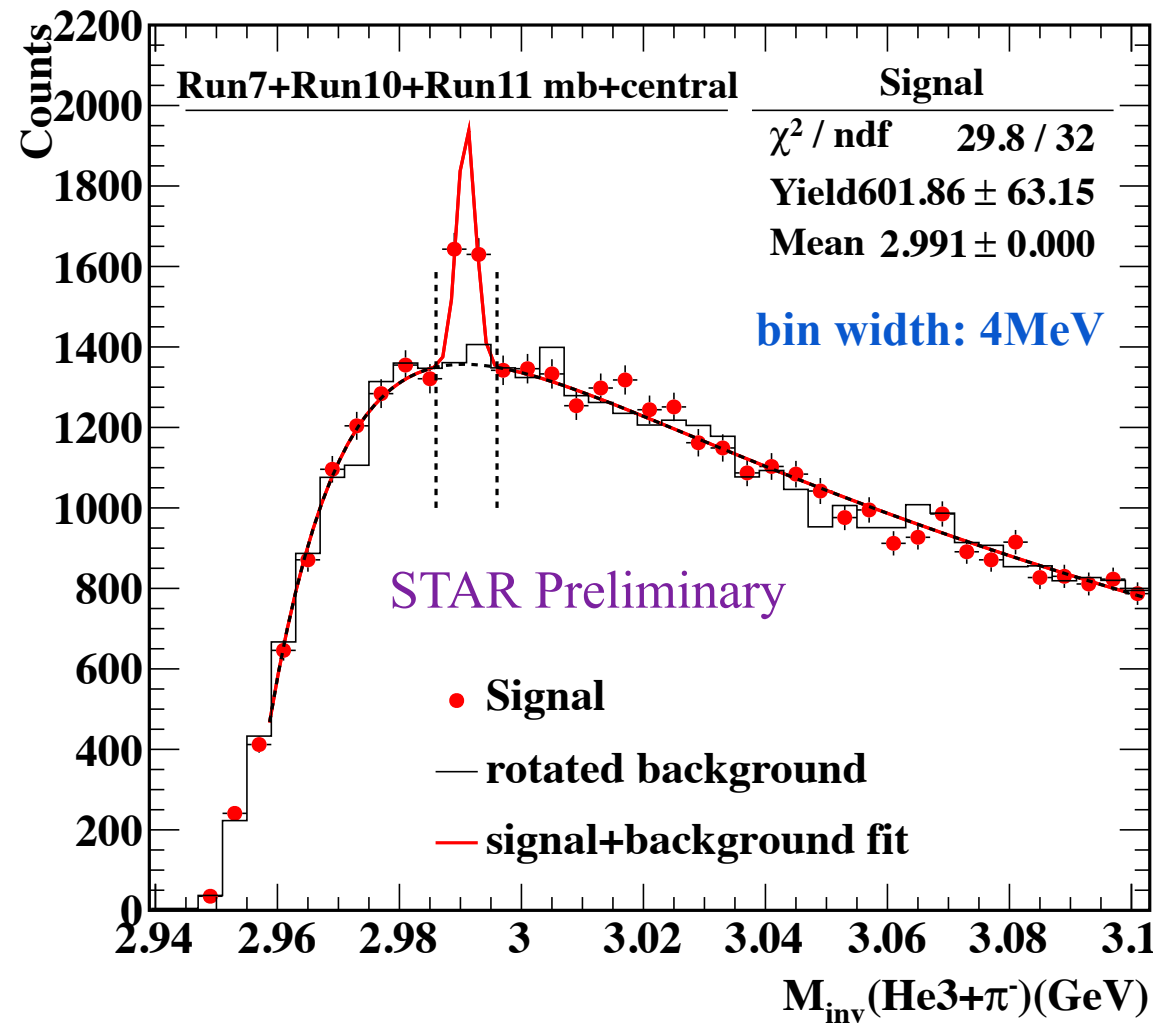


	Run10 7.7	Run10 11.5	Run11 19.6	Run11 27	Run10 39	Run10 200(minbias)	Run10 200(central)	Run7 200 minbias
${}^3\text{He}$	8587	7161	6321	5312	6456	5822	11181	2264
${}^3\overline{\text{He}}$	0	0	0	19	133	2213	4241	861

★ π^-

$$|n\sigma_\pi| < 2$$

Statistics: Run7+Run10+Run11 minbias+central, totally 609.89M events

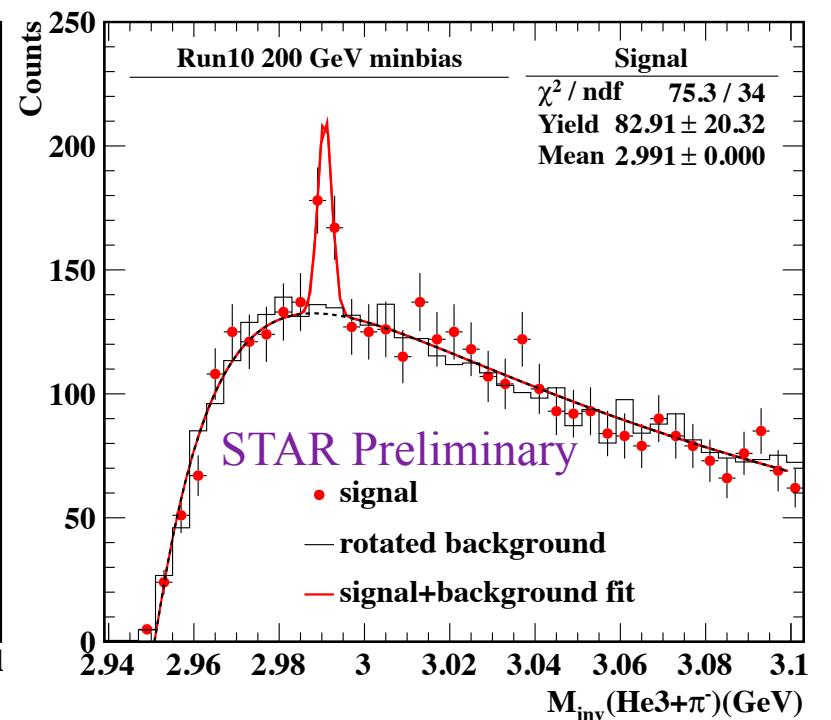
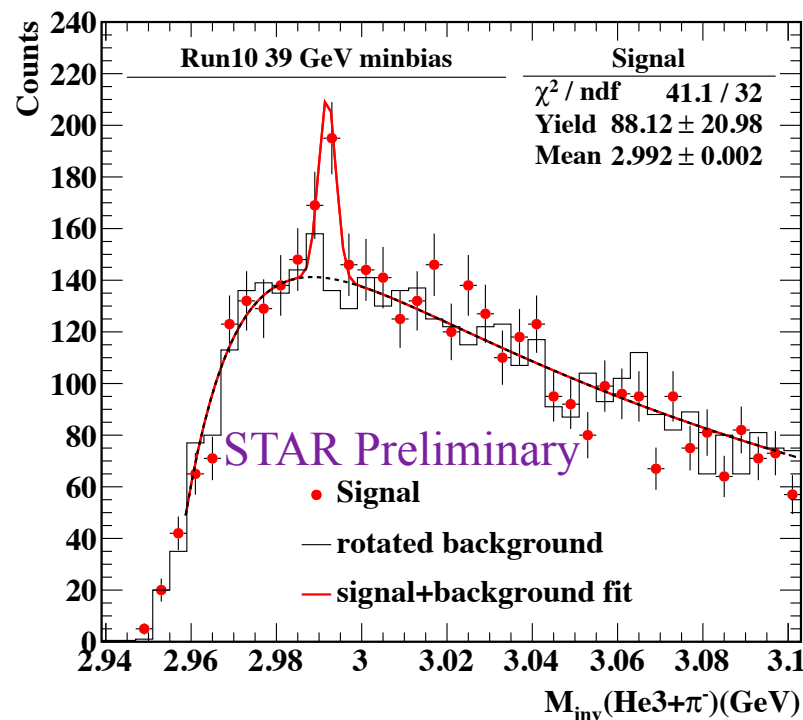
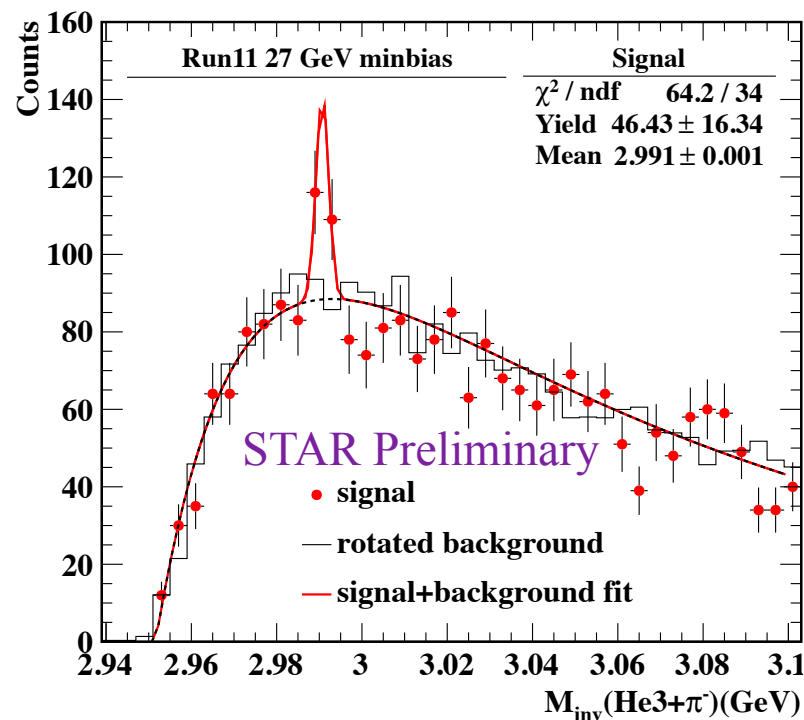
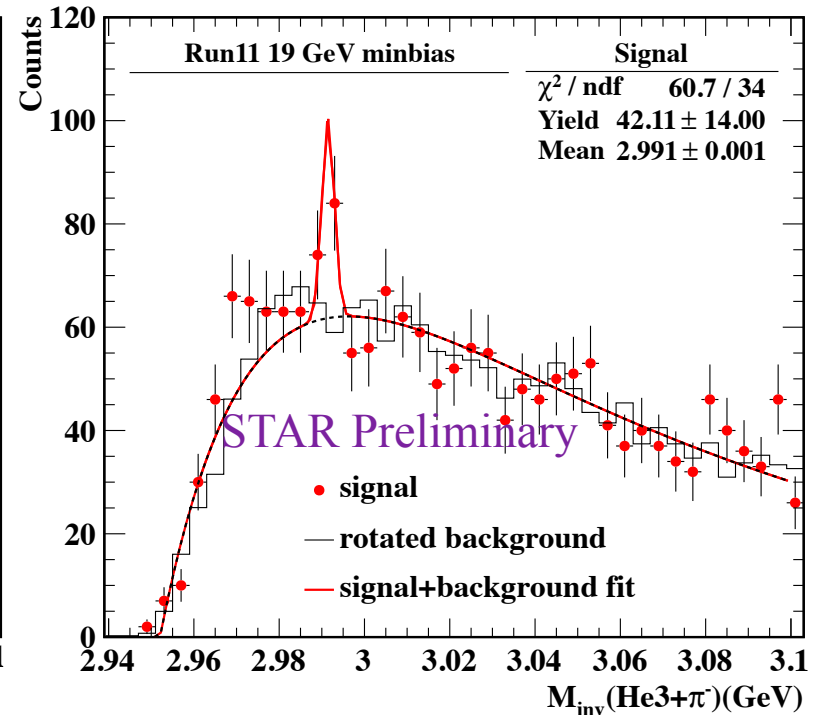
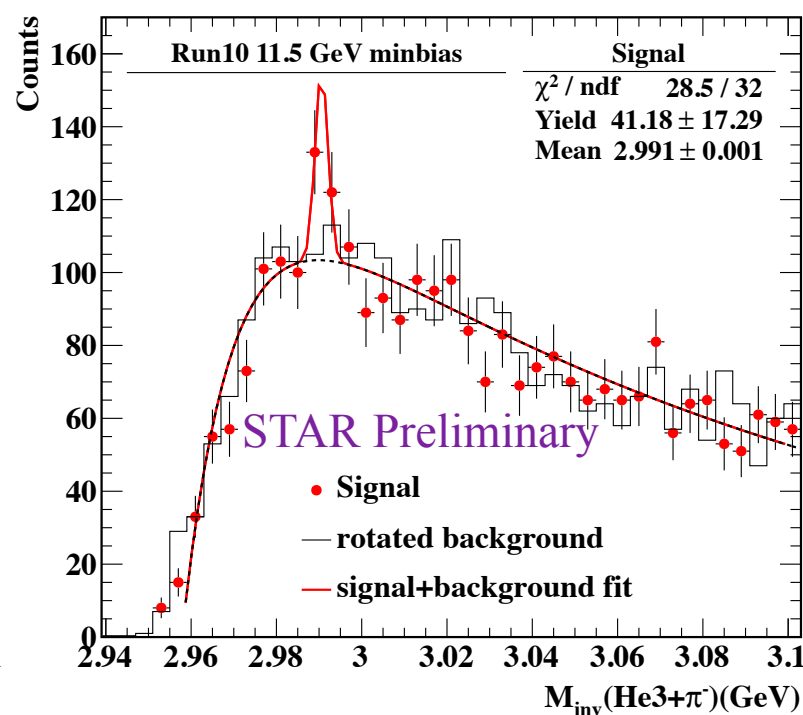
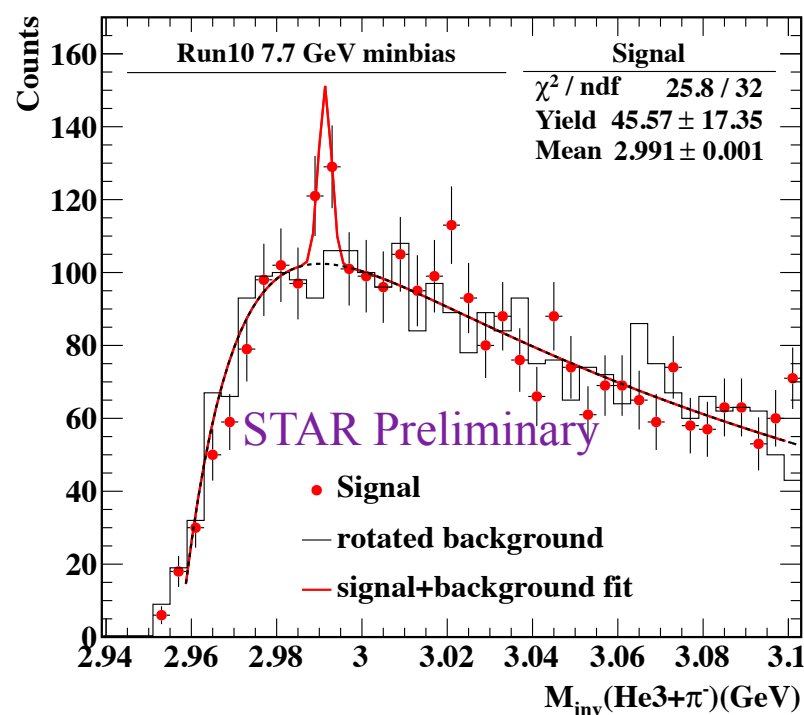


Background Estimation: Rotated background fit

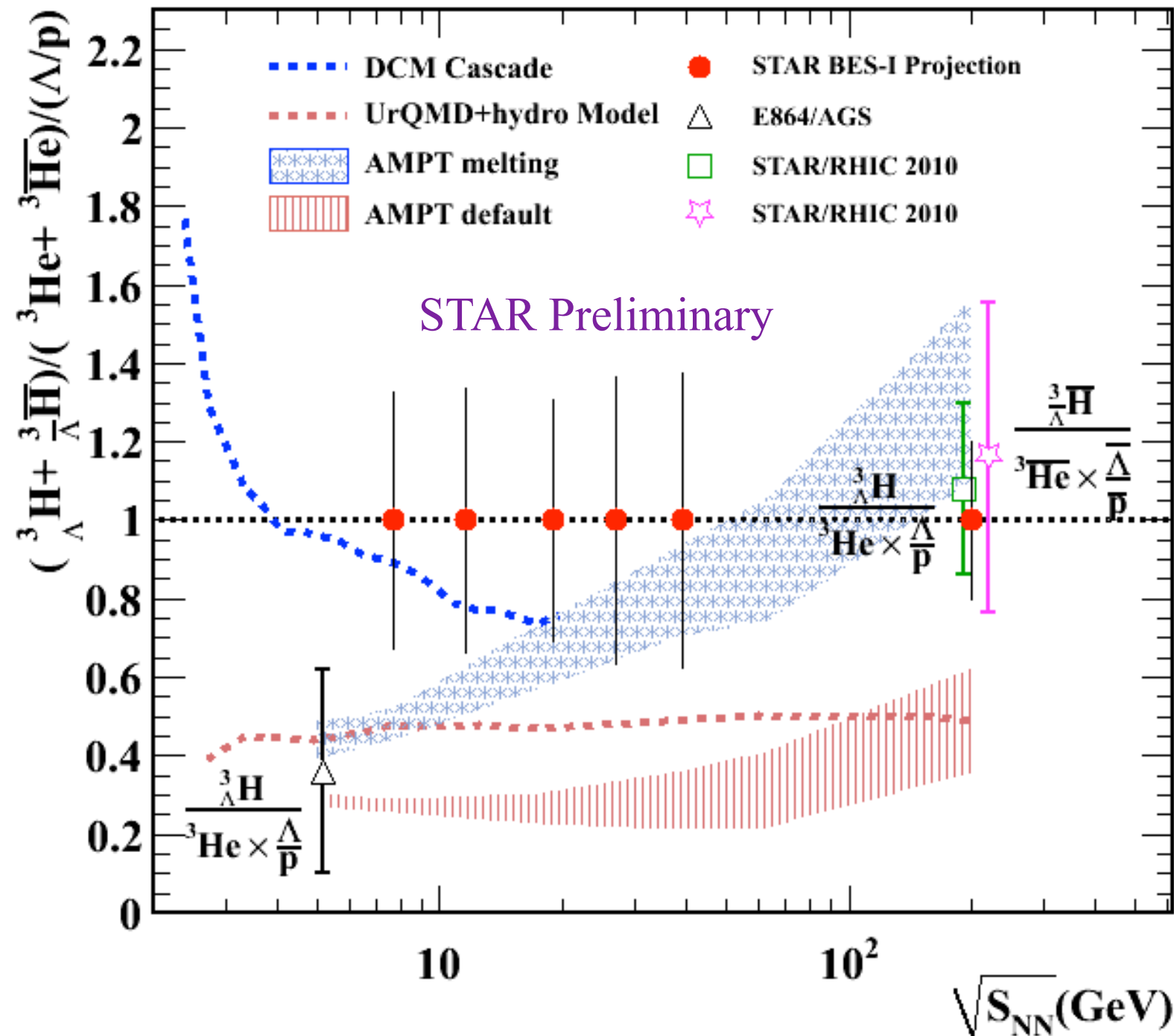
Signal: Bin-bin counting in a fixed mass range : [2.986, 2.996] GeV

${}^3_{\Lambda}\text{H} + {}^3_{\Lambda}\bar{\text{H}}$ produced: 601.9 ± 63.2 significance: 9.5σ

${}^3_{\Lambda}\text{H} + {}^3_{\bar{\Lambda}}\bar{\text{H}}$ produced at $\sqrt{S_{NN}} = 7.7, 11.5, 19.6, 27, 39, 200\text{GeV}$

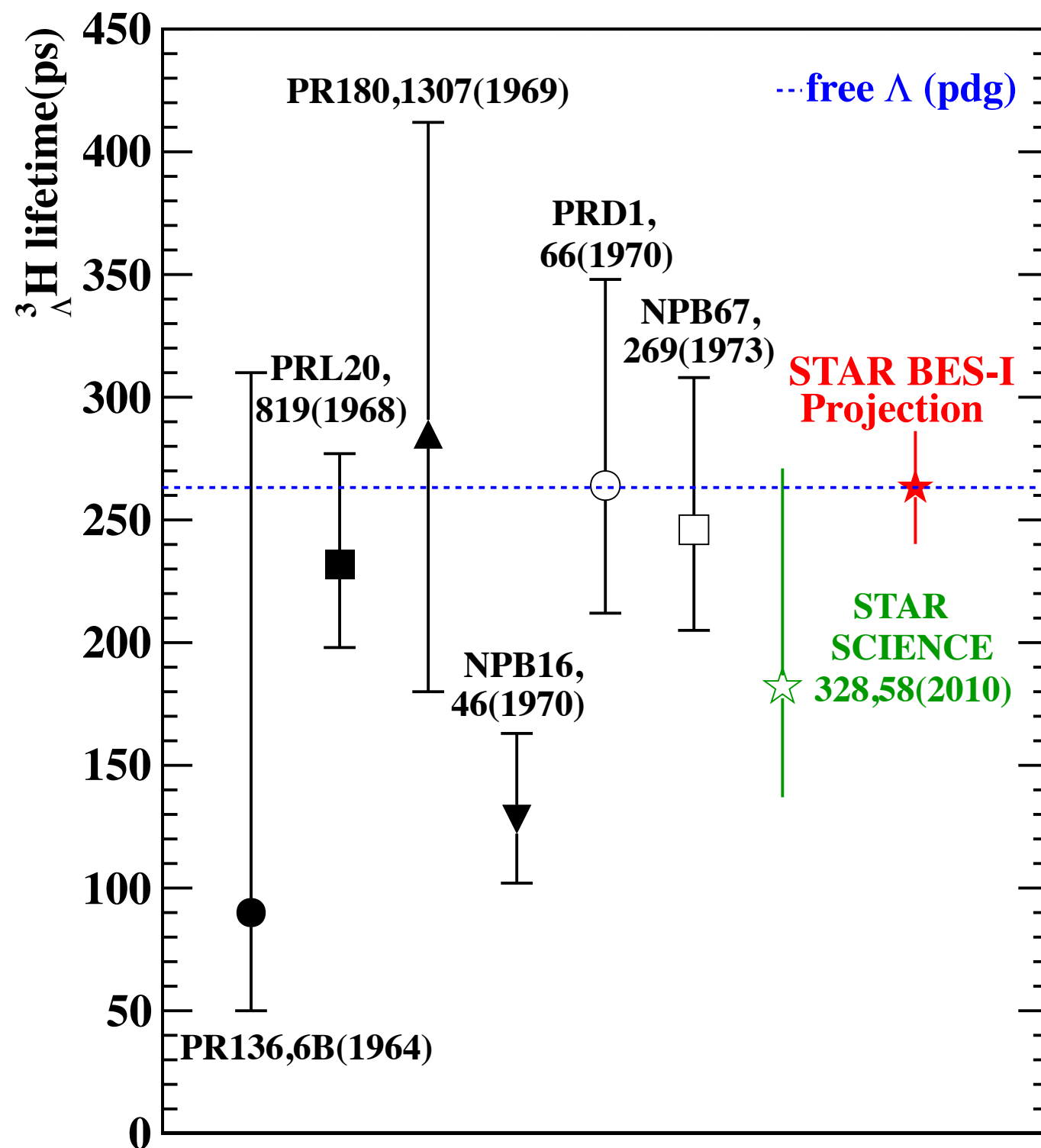


STAR BES-I Projection on S3



To get a statistically satisfying S3 result, we need about 10 times more statistics for each energy

STAR BES-I Projection on Lifetime



A statistically improved lifetime is expected

Conclusions and QM2012 Plan

- ★ Over 600 ${}^3_{\Lambda}\text{H}$ and ${}^3_{\bar{\Lambda}}\bar{\text{H}}$ are reconstructed with significance 9.5σ
- ★ ${}^3_{\Lambda}\text{H}$ and ${}^3_{\bar{\Lambda}}\bar{\text{H}}$ signal at separate energies is reconstructed

Results to be presented at QM2012:

- ★ Preliminary ${}^3_{\Lambda}\text{H}$ and ${}^3\text{He}$ spectra
- ★ Preliminary beam energy dependence of strangeness population factor
- ★ A statistically improved lifetime

Thanks!